Module 1: Section 1D: A Closer Look at the Standards for Mathematical Content: High School Algebra Sample Tasks

Task 1:

Problem Set

1. Estimate the solution to the system of equations by graphing and then find the exact solution to the system algebraically.

$\begin{cases} 4x + y = -5 \\ x + 4y = 12 \end{cases}$

$-4(x + 4y = 12)$

$4x + y = -5$

$-4x - 16y = -48$

$-15y = -53$

$y = 3.5$

$4x + 3.5 = -5$

$4x = -8.5$

$x = -2.125$

$4x + 0 = -5$

$x = -1.25$

$0 + y = -5$

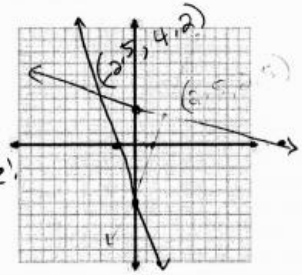
$x + 0 = 12$

$0 + 4y = 12$

$y = 3$

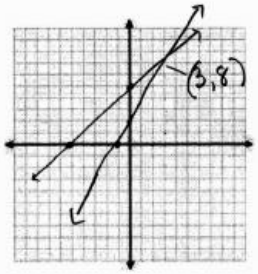
close!

$(-2.125, 3.5)$

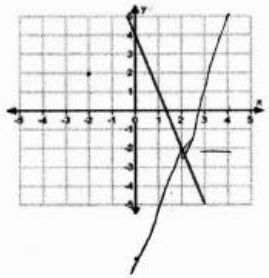


2.
   a. Without graphing, construct a system of two linear equations where (0, 5) is a solution to the first equation but is not a solution to the second equation, and (3, 8) is a solution to the system.
   b. Graph the system and label the graph to show that the system you created in part (a) satisfies the given conditions.

$\begin{cases} -x + y = 5 \\ 2x - y = -2 \end{cases}$



3. Consider two linear equations. The graph of the first equation is shown. A table of values satisfying the second equation is given. What is the solution to the system of the two equations?



x	−4	−2	0	2	4
y	−26	−18	−10	−2	6

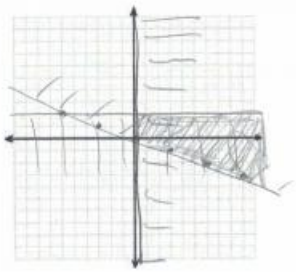
$(2, -2)$

4. Graph the solution to the following system of inequalities: $\begin{cases} x \geq 0 \\ y < 2 \\ x + 3y > 0 \end{cases}$

$x + 3y = 0$

$3y = -1x$

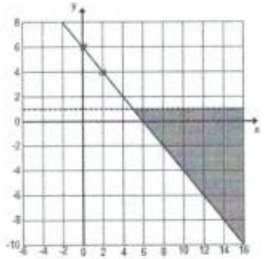
$y = -\frac{1}{3}x + 0$



5. Write a system of inequalities that represents the shaded region of the graph shown.

$y > 1$

$y \geq -\frac{2}{3}x + 6$



6. For each question below, provide an explanation or an example to support your claim.
   a. Is it possible to have a system of equations that has no solution? yes if the lines never cross each other
   b. Is it possible to have a system of equations that has more than one solution? if the lines are right on top of each other
   c. Is it possible to have a system of inequalities that has no solution? if the shading goes opposite ways

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Task 2:

Problem Set A

Solving Quadratic Equations Efficiently

For each of the given quadratic equations find the solutions using an efficient method. You must use at least three different methods and tell which method you are using for each.

1. $x^2 + 17x + 60 = 0$

2. $x^2 + 16x + 39 = 0$

3. $x^2 + 7x - 5 = 0$

4. $3x^2 + 14x - 5 = 0$

5. $x^2 - 12x = -8$

6. $x^2 + 6x = 7$

Describe the process for solving a quadratic by each strategy. Tell how you know when to use each strategy.

7. Completing the Square

you do half of the x term and square it and add that and subtract it. Do this when you have to graph the vertex

8. Factoring

You do the box. Do this when the numbers work

9. Quadratic Formula

Do $\frac{-b \pm \sqrt{b^2-4ac}}{2a}$ do this when the box doesn't work

Problem Set B

Graph Quadratics and find essential features of the graph and solve systems of equations. **Graph the quadratic function and supply the desired information about the graph.**

10. $f(x) = x^2 + 8x + 13$

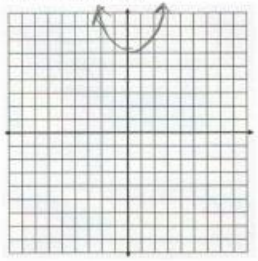
a. Line of symmetry:

b. x-intercepts: n/a

c. y-intercept: 13

d. vertex:

can't graph



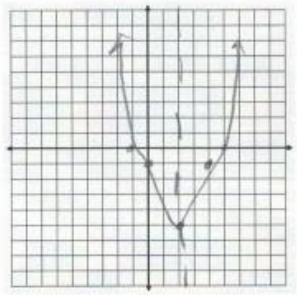
11. $f(x) = x^2 - 4x - 1$

a. Line of symmetry: 2

b. x-intercepts: -1 and 5

c. y-intercept: -1

d. vertex: (2, -5)



Solve each system of equations using an algebraic method and check your work!

12. $\begin{cases} 3x + 5y = 15 \\ 3x + 2y = -6 \end{cases}$

13. $\begin{cases} y = -7x + 12 \\ y = 5x - 36 \end{cases}$

14. $\begin{cases} y = 2x + 12 \\ y = -10x + x^2 \end{cases}$

15. $\begin{cases} y = 24x - x^2 \\ y = -8x + 48 \end{cases}$

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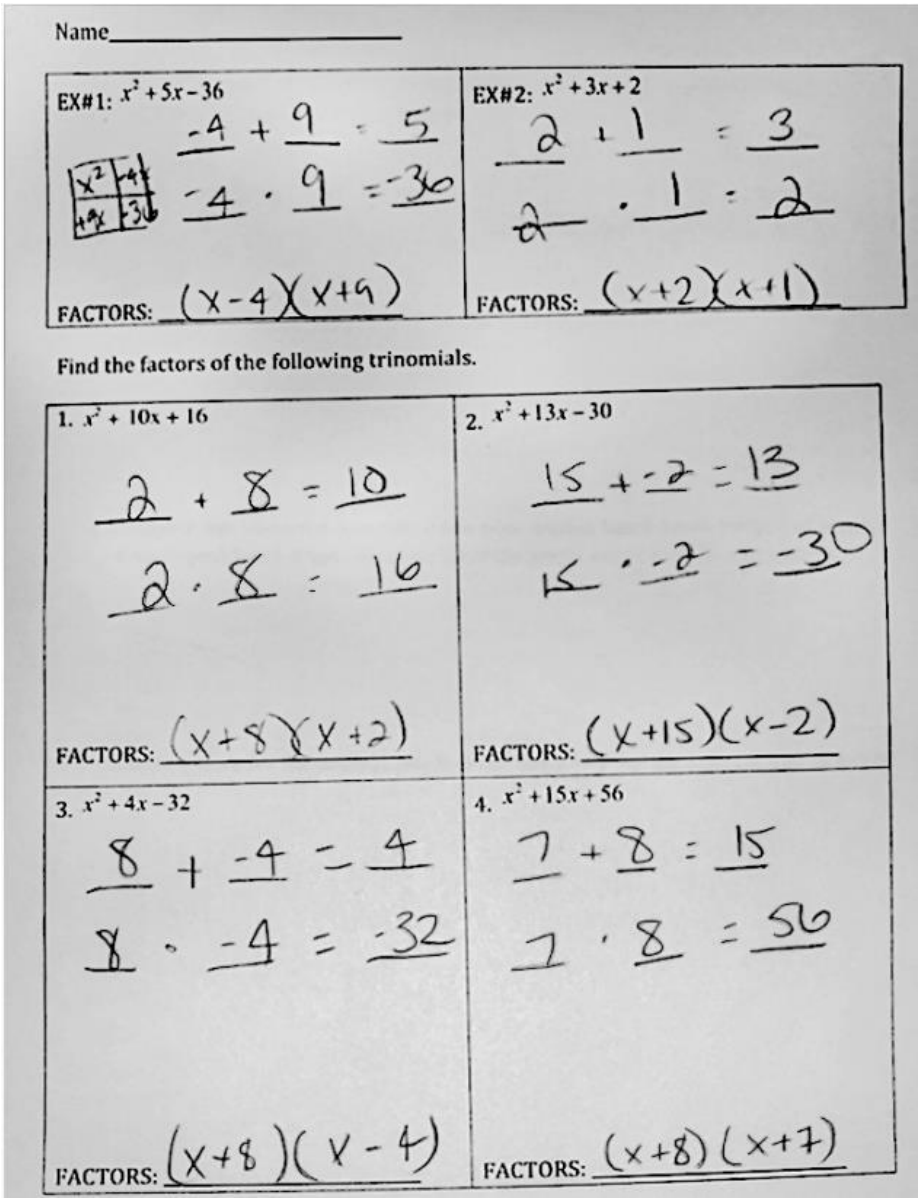
Task 3:



Name_____

EX#1: $x^2+5x-36$

$-4 + 9 = 5$

$-4 \cdot 9 = -36$

FACTORS: $(x-4)(x+9)$

EX#2: x^2+3x+2

$2 + 1 = 3$

$2 \cdot 1 = 2$

FACTORS: $(x+2)(x+1)$

Find the factors of the following trinomials.

1. $x^2+10x+16$

$2 + 8 = 10$

$2 \cdot 8 = 16$

FACTORS: $(x+8)(x+2)$

2. $x^2+13x-30$

$15 + -2 = 13$

$15 \cdot -2 = -30$

FACTORS: $(x+15)(x-2)$

3. $x^2+4x-32$

$8 + -4 = 4$

$8 \cdot -4 = -32$

FACTORS: $(x+8)(x-4)$

4. $x^2+15x+56$

$7 + 8 = 15$

$7 \cdot 8 = 56$

FACTORS: $(x+8)(x+7)$

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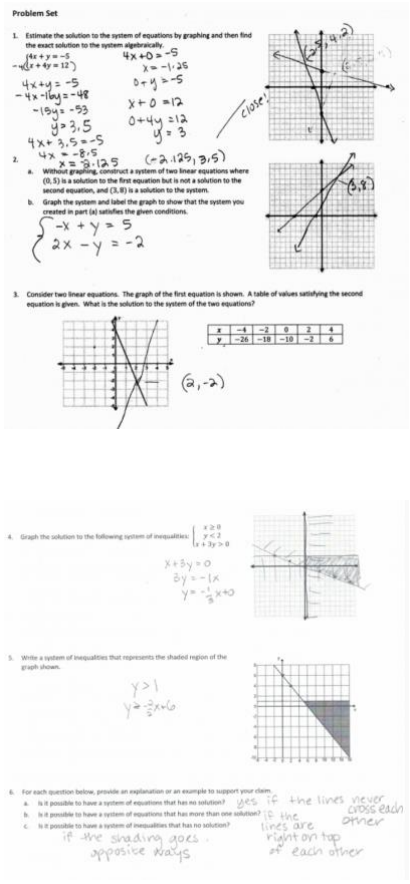
Participant Guide

Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
Sample Task 1: 	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

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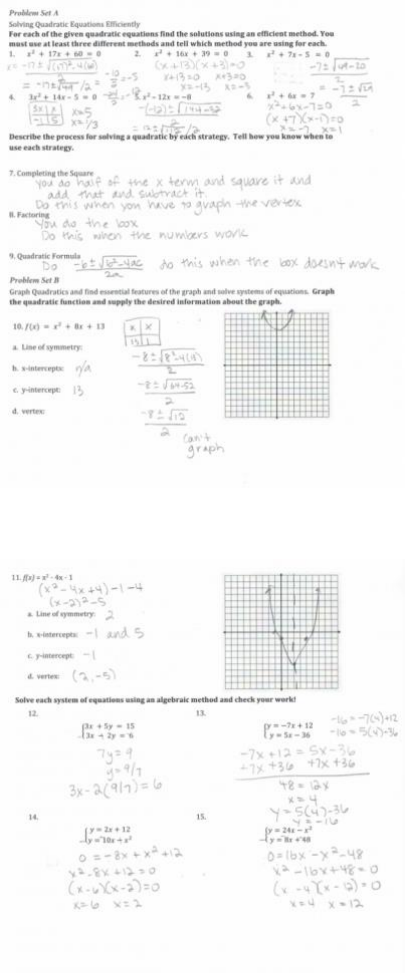
Student Work Sample	Standard of Mathematical Content Focus	Degree of Alignment	Standards of Mathematical Practice (SMP) Focus
Sample Task 2: 	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

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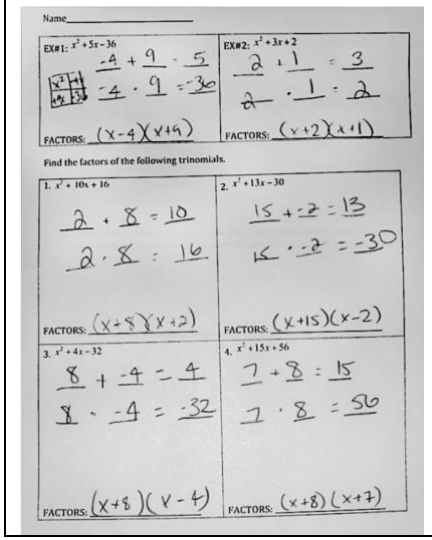
Sample Task 3: 	Can you identify the targeted content standard(s) for this task?	• None/Weak • Partial • Strong	Can you identify the targeted practice standard(s) for this task?

Name_____

EX#1: $x^2+5x-36$ $-4+9=5$ $-4\cdot 9=-36$ FACTORS: $(x-4)(x+9)$

EX#2: x^2+3x+2 $2+1=3$ $2\cdot 1=2$ FACTORS: $(x+2)(x+1)$

Find the factors of the following trinomials.

1. $x^2+10x+16$ $2+8=10$ $2\cdot 8=16$ FACTORS: $(x+8)(x+2)$

2. $x^2+13x-30$ $15+-2=13$ $15\cdot -2=-30$ FACTORS: $(x+15)(x-2)$

3. $x^2+4x-32$ $8+-4=4$ $8\cdot -4=-32$ FACTORS: $(x+8)(x-4)$

4. $x^2+15x+56$ $7+8=15$ $7\cdot 8=56$ FACTORS: $(x+8)(x+7)$

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Facilitator's Guide

Throughout facilitation of this activity it will be important to remind participants:

- Use the grade-level overview to determine the relevant cluster(s) to look at more closely
- Questions regarding Standards for Mathematical Practices will only be indicated where specific practices were identified within the source of the task alignment. Additionally, emphasize to participants the statement at the end of each cluster within the *KAS for Mathematics*, "The identified mathematical practices, coherence connections, and clarifications are possible suggestions; however, they are not the only pathways."

Sample Task 1:

This assignment is strongly aligned to the standards.

Overview

Students solve and reason about systems of two or more equations or inequalities. The assignment is strongly aligned to the standards because problems ask students to solve systems of linear equations exactly and approximately with graphs (KY.HS.A.20.b) and to "graph the solutions set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes" (KY.HS.A.25.b).

Related Standards

We looked at how well the assignment aligned to the following standards:

KY.HS.A.20: Solve systems of linear equations in two variables.

- KY.HS.A.20.b: Solve systems of linear equations with graphs, substitution and elimination, focusing on pairs of linear equations in two variables.

KY.HS.A.25: Graph linear inequalities in two variables.

- KY.HS.A.25.b: Graph the solution set to a system of linear inequalities as the intersection of the corresponding half-planes.

Why is this assignment Strongly aligned?

In eighth grade, students learn about systems of two linear equations and how to solve them algebraically or by graphing (standard KY.8.EE.8). In high school, they extend their understanding of systems of equations to include linear equations, non-linear equations, and linear inequalities. This assignment is appropriate for high school because it asks students to (a) work from a verbal description of a system of linear equations, (b) engage with a system of equations where one equation is presented in graphical form and the other in table form, (c) reason about the possible solution types of systems in general, and (d) graph, solve, and reason about systems of linear inequalities.

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Standards KY.HS.A.20.b and KY.HS.A.25.b are procedural, requiring students to solve systems by graphing and algebraically. The assignment requires these procedures explicitly and from a variety of function formats. The procedural nature of the problems aligns with the procedural requirements of the standards.

Practice Standards

The assignment provides students the opportunity to engage with Mathematical Practice Standard #1 ("Make sense of problems and persevere in solving them") and Mathematical Practice Standard #7 ("Look for and make use of structure"). Students might "analyze givens, constraints, relationships, and goals" when writing a system of equations with given conditions, without first constructing a graph. They might also "see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects" when solving a system of three linear inequalities by reasoning about their corresponding equations (Mathematical Practice Standard #1). They might also "see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects" when solving a system of three linear inequalities by reasoning about their corresponding equations (Mathematical Practice Standard #7).

Sample Task 2:

This assignment is partially aligned to the standards.

Overview

High school students solve quadratic equations using different methods, graph quadratic functions and identify key features of the graphs and solve systems of linear and quadratic equations. The assignment is partially aligned to the standards. While it requires students to solve and graph some appropriately complex equations, it overemphasizes the use of specific solution methods, doesn't involve complex solutions, and doesn't ask students to interpret the key features of the functions they are asked to graph.

Related Standards

We looked at how well the assignment aligned to the following standard:

KY.HS.A.19: Solve quadratic equations in one variable.

- KY.HS.A.19.a: Solve quadratic equations by taking square roots, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.

KY.HS.A.21: Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.

KY.HS.F.1: Understand properties and key features of functions and the different ways functions can be represented.

- KY.HS.F.1.c: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.

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WHY IS THIS ASSIGNMENT PARTIALLY ALIGNED?

Standard KY.HS.A.19.a requires students to learn multiple methods for solving quadratic functions (taking square roots, the quadratic formula, and factoring). This assignment gives students a chance to use a variety of those methods. However, the assignment also reinforces the idea that there is a "correct" method for solving certain types of quadratic functions. Although classroom discussions might focus on the type of quadratic function that lends itself easily to each method, the idea of a "correct" method is not a requirement of the standards.

In addition, this assignment encourages the use of completing the square as a method. This method is aligned to KY.HS.A.19.c, which is a plus standard. Plus (+) Standards are additional mathematics concepts students should learn in order to take advanced courses such as calculus, advanced statistics or discrete mathematics, but they are not required learning for all students.

Standards KY.HS.A.19.a and KY.HS.A.21 require students to procedurally solve quadratic equations and systems of linear and quadratic equations, and this assignment allows them to do just that. However, there is an expectation that students will solve systems of one linear and one quadratic function (true for only two of the four systems in this assignment). Finally, the problems aligned with KY.HS.F.1.c do ask for some key information about the graph, but do not ask students to interpret these key features, as required by the standard.

Note: Within KY.HS.A.19.a there is an expectation that students will encounter complex solutions when solving, expressing them in the form a + bi (not addressed at all in this assignment). However, recognizing complex solutions is not expected of students in a foundational course. For additional information regarding the alignment of this standard within the content offered within certain high school courses, use the High School Mathematics Matrix Standards by Course 2019-2020.

Practice Standards

The assignment allows students to engage with Mathematical Practice Standard #1 ("Make sense of problems and persevere in solving them") by solving systems of one linear and one quadratic equation—students must combine their understanding of how systems of equations operate with their understanding of solving for unknown values in a quadratic equation to solve for x and y. Students also have the opportunity to engage with Mathematical Practice Standard #7 ("Look for and make use of structure") when solving and graphing quadratic equations—students must understand how to find the key features of a quadratic graph from the equation or from an algebraic manipulation of the equation to an equivalent form.

Sample Task 3:

This assignment is weakly aligned to the standards.

OVERVIEW

High school students factor algebraic expressions at an introductory level of complexity. The assignment is weakly aligned to the standard because it doesn't ask students to use the factors beyond simply finding them, while the standard requires students to identify the zeros (the values of x for which the expression is equal to zero) and use this information to sketch a graph to represent the algebraic expression.

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Related Standards

We looked at how well the assignment aligned to the following standards:

KY.HS.A.7: Identify roots of polynomials when suitable factorizations are available. Know these roots become the zeros (x-intercepts) for the corresponding polynomial function.

Why is this assignment weakly aligned?

Standard KY.HS.A.7 requires students to find the roots of a polynomial and demonstrate an understanding of how these roots relate to the graph of the corresponding polynomial function. Because the computations required by this assignment are so simple, they should be helping to build students' understanding of the connections between the graph, the zeros, and the factors of quadratic functions, and to make sense of their structures. However, the assignment doesn't allow students to make those connections.

The assignment requires students to find the factors of trinomials and to write the factors as a product of two binomials. Each of the six problems are factorable and the factors are simple numbers, so students are likely to be able to factor in their heads. Although factoring trinomials is a grade-level concept, high school students should be factoring to build their conceptual understanding of quadratic functions, not factoring for the sake of honing a stand-alone skill. If the assignment had asked students to use the factorization to draw a sketch of the graph, it would be more strongly aligned to KY.HS.A.7.

Practice Standards

The assignment does not give students the opportunity to engage in any mathematical practice standards. Were it more aligned to the standard, students would likely use Mathematical Practice Standard #7 ("Look for and make use of structure") when they apply the understanding that the factors (x - a)(x - b) indicate that the quadratic function has zeros, or x-intercepts, at (a, 0) and (b, 0).

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